

ARTICLE

Economic Impacts of Clinical and Sub Clinical Mastitis on Dairy Farms

Muhammad Shafeeq¹ Afshan Muneer² Amjad Islam Aqib^{3*} Nimra Kirn⁴

1. Department of Clinical Medicine and Surgery, University of Agriculture Faisalabad, 38000, Pakistan

2. Department of Zoology, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, 63100, Pakistan

3. Department of Medicine, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, 63100, Pakistan

4. Department of Food Science, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, 63100, Pakistan

ARTICLE INFO

Article history

Received: 15 November 2021

Accepted: 20 December 2021

Published Online: 30 December 2021

Keywords:

Clinical

Subclinical

Mastitis

Dairy

Economic

Loss

Milk

Culling

Somatic cell count (SCC)

ABSTRACT

Studies have reported on the economic impacts of clinical and subclinical mastitis on dairy farms. Bovine mastitis is a disorder that affects dairy farms and has a major economic impact. Most of the economic losses are the result of mastitis. Mastitis is an invasive infection that is among the most numerous and highly complicated infections in the dairy sector. Mastitis is one of the most expensive diseases in terms of production losses among animal diseases. Mastitis reduces milk production, changes milk composition, and shortens the productive life of infected cows. Farmers must concentrate on avoiding mastitis infection whilst putting in place and following a mastitis control program. Bovine mastitis, the most significant disease of dairy herds, has huge effects on farm economics. Mastitis losses are due to reduced milk production, the cost of treatments, and culling. Major factors related to low milk yield could be low genetic potential as well as poor nutritional and managerial approaches. Most of the losses are related to somatic cell count (SCC), which is characterised by an increase in the percentage of milk. Culling costs are the costs of rearing or buying a replacement animal, mostly heifers. Overhead impacts include the replacement animals' lower milk supply effectiveness. The expense of replacing animals prematurely due to mastitis is one of the most significant areas of economic loss.

1. Introduction

Mastitis is perhaps the most common and expensive infectious disease that plagues dairy cows. Mastitis has a substantial influence on milk output, milk quality, and

the herd's management. Bovine mastitis is marked by a prolonged and inflammatory response of the mammary gland to either physical trauma or infections caused by microorganisms. It's a potentially deadly mammary gland

*Corresponding Author:

Amjad Islam Aqib,

Department of Medicine, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, 63100, Pakistan;

Email: amjadislamaqib@cuvas.edu.pk

DOI: <https://doi.org/10.30564/vsr.v3i2.4119>

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infection that's most prevalent in dairy cows all around the world. Pakistan ranks in a significant position among the major dairying countries around the globe. Major factors related to low milk yield could be low genetic potential as well as poor nutritional and managerial approaches. These factors affect the milk producing organs ^[1]. ^[2] checked the incidence of mastitis in different species. They found the occurrence of *S. aureus* to be 61.64%. The maximum resistance (58.6%) against penicillin was observed. It was concluded that resistance may be transferred to children by consuming affected milk. Among the various threats faced by dairy animals, mastitis are one of the major livestock problems in Pakistan ^[3]. Mastitis causes economic losses that include not only the cost of antibiotics and management practices, but also milk loss, premature culling, mortality, and infected milk discarding ^[4]. Mastitis is generally categorized on the basis of duration (acute or chronic) and on the basis of the appearance of symptoms (subclinical and clinical). Subclinical mastitis infections don't cause any visible changes in milk or udder appearance, making it difficult to detect. Clinical mastitis is inflammation of the mammary gland showing all signs of inflammation in teats and udder as well as in milk, while in subclinical mastitis there is inflammation but no signs are evident in teats and udder. Subclinical mastitis triumphs over clinical form in terms of economic losses. Clinical mastitis, on the other hand, is a major concern in terms of animal welfare ^[5].

According to the findings, the ^[6] somatic cell count (SCC) criterion for milk quality might be a significant part of a control strategy. In all, 396 quarters were taken from nursing cross-bred cows (Holstein & Zebu). Intra-mammary infection was seen in 56% of these quarters. Mastitis is an epidemic illness that is among the most prevalent and significant infections in the milk industry. Mastitis has an effect on food quality, direct and indirect, related to technical and hygienic characteristics and fundamental milk composition ^[7]. Reported mastitis is still the most expensive medical and financial problem in the milk production industry. Dairy farmers should priorities mastitis prevention while developing and adhering to a mastitis control programmer. Farmers may wait until mastitis occurs before taking steps to begin fixing the problem. The farmer's complete understanding and precise classification of mastitis-causing chemicals are critical to success.. New therapeutic approaches which do not rely on antibiotics may be required. The majority of studies on mastitis' economic impact have been undertaken in wealthy countries. ^[8]. Mastitis losses are compensated for by reduced milk production, culling, and treatment expenses, which account for 8%, 14%, and 78%, 8%,

respectively. Mastitis' economic impact varies and should be calculated at the farm or herd level because it is influenced by local, regional, epidemiological, managerial, and economic factors ^[9]. Subclinical mastitis (SCM) is characterized as a rise in the concentration of somatic cell count (SCC) in milk, which many farmers underestimate due to the lack of evident abnormalities in milk. Due to the incidence of both subclinical and clinical mastitis on the farm, disease management results in increased disease losses ^[10].

Clinical mastitis has an extremely low death rate on average, although predicted culling happens more commonly after clinical and subclinical mastitis ^[11]. All dairy farms incur losses resulting from environmental mastitis, according to ^[12]. The value of antibiotics in controlling environmental mastitis is greatly reduced compared to their value in controlling contagious pathogens. Mastitis is often regarded as one of the most prevalent infectious diseases causing economic damage in the dairy sector worldwide ^[9]. Mastitis has severe consequences due to the disease's chronic condition, large economic losses that occur every year, and a dramatic fall in milk output ^[8] in the mammary gland. Cow performance was assessed in terms of milk output, milk composition, and mammary inflammation levels. Reported ^[13] that mastitis has been observed to have a direct impact on the technical attributes and sanitary quality of milk, as well as an indirect impact on its inherent qualities. Milk is one of the most essential nutritional foundations for the vast majority of a populace. Milk output has increased as a result of natural screening, and also enhanced cow feed and care, according to ^[14]. Poor udder fitness, particularly owing to mastitis, is among the most significant impediments to high milk supply. About 60% to 70% of the anti-microbials used on dairy-farms are used to prevent and cure mastitis. Mastitis sig Mastitis has been shown to be the maximum portent monetary apprehension in the dairy sector, as well as a source of animal welfare issues. The California Mastitis Test was used to assess the amount of inflammationificantly reduces milk supply and farm earnings. Mastitis has the potential to endanger public health since it can spread zoonoses and illnesses caused by dietary poisons ^[15]. As a result of the high likelihood of infection with germs from the cattle prairie, milking equipment, and direct intake of raw milk is not suggested. As a result, milk pasteurization is required to ensure its safety and to extend its shelf life ^[15].

Sub-clinical mastitis in dairy buffaloes in four districts (Sialkok, Lahore, Narowaal, and Okara) of the province of Punjab, Pakistan. A total of 600 animals living under different managerial settings were screened for

subclinical mastitis. The overall recorded prevalence of subclinical mastitis was 44%. Animals which were kept in backyards showed the highest (58%) prevalence, followed by small farms in peri-urban areas (42%). Whereas in the well-organized farms with better management, the lowest prevalence (32%) was recorded. Climate and breeding at different heights significantly influence the prevalence of clinical mastitis. Local breeds (Zebu cattle) were found to be resistant to mastitis, whereas exotic breeds (Belfast cattle) showed a higher prevalence. The rate of clinical mastitis cases was 41.17% during the summer and after the monsoon season. According to ^[11], clinical and subclinical mastitis is by far the most common fabrication illness in dairy herds worldwide. Milk supply and content can be influenced by moderate to severe brief despondency and, in the absence of a treatment, a lengthy impact. Changes in milk composition may be practically overlooked in economic considerations due to the withdrawal interval following medication ^[11,8]. The major parts of the economic effects of mastitis are the decline in dairy production based on the clinical and subclinical cases, milk decommissioning, the expense of medications used for the treatment of medical instances, the labor costs associated with the treatment of quantifiable cases, and the decrease in milk sales ^[18]. A reduction in milk output has been identified as the component with the largest economic impact on the overall cost of mastitis. Changes in milk composition may be ignored in economic estimates due to the time it takes to recover following therapy ^[18].

2. Milk Production Falls

Mastitis losses are due to reduced milk production, cost of treatments, and culling. Milk supply is significantly reduced in both clinical and subclinical mastitis. Clinical mastitis has been estimated to have caused economic loss ^[19]. Subclinical mastitis output losses are frequently assumed to be a straight log-linear connection between SCC and test-day data ^[20]. However, even after complete recovery from subclinical mastitis, milk supply does not improve. According to study, an estimated incidence of mastitis has an influence on the milk supply of a dairy cow, which produces 7000 kg of milk every lactation. Mastitis, both clinical and subclinical, causes a decrease in milk production. According to the National Mastitis Council, annual losses owing to reduced output plus preventative and control expenditures in the United States surpass USD 2 billion. Both clinical and subclinical mastitis impact milk output. Even after complete recuperation, milk production does not improve, therefore the economic loss remains significant. Despite the fact

that antibiotic therapy prevented preclinical mastitis from developing into clinical mastitis ^[21].

According to ^[22] the rate of the mastitis and its impact on milk yield. They discovered rate of mastitis in first, second and third equality 19.94, 33.74 and 40.74%, separately. Milk misfortunes between 0.76 to 4.56 kg/d. Complete milk misfortune was 600.87 kg for steers that progressed toward becoming mastitis in initial a month and a half of lactation. Others were identified by crowds people looking at bovines whose electrical conductivity of milk expanded by >15% when contrasted and their past multi day moving normal and had a simultaneous reduction in milk yield. It has been suggested ^[23] that mastitis makes tremendous money related to hardships farmers. They performed starter to recognize the microorganisms responsible for mastitis in dairy. California Mastitis Test was used to screen the subclinical mastitis they found 313(45.82%) positive. Directed an examination ^[24] to discover the prevalence of subclinical mastitis in primiparous Simmental meat dairy cattle. To discover subclinical mastitis milk tests were gathered aseptically from each quarter. The 32% cows and 18% quarters were discovered positive for subclinical disease. Throughout the world, diseases of mammary gland like mastitis in small and large animals (ruminants) that cause significant loss to the dairy sector specially in milking animals. To counter act this problem by evaluating main organisms that may lead to intra-mammary infection, environment of the animal, somatic cell count, milk quality and milk yield that help to control to the incidence of infection ^[25] determined that mastitis causes huge loss in milking animals that lead to decline in milk production and affected milk quality. They collected a 6522 milk samples in the period of 52 months from the milking animals (buffalo, cattle, sheep and goat). The screening of milk samples was done by WST and SFMT at sub-clinical mastitis and overall prevalence was 23.18%.

3. Major Economic Problem

Bovine mastitis is a disease that primarily affects dairy farms and has a major economic impact. Mastitis is among the major economic difficulties in dairy cattle production, according to ^[26]. Even though there has been a general decrease in the incidence of mastitis in recent times, high incidence rates of 25-45 percent are still being revealed. Mastitis is a multi - factorial disease in which the environment, pathogens, and host (cow) all interact ^[27]. Bovine mastitis, an inflammation of the mammary gland, is the most common disease in dairy cattle, having caused economic costs due to decreased milk production and low milk quality. The etiological agents include a wide

range of gram-positive and gram-negative bacteria which can be highly infectious (e.g., *Staphylococcus aureus*, *Streptococcus agalactiae*, *Mycoplasma* spp.) or ecologic in nature (e.g., *Escherichia coli*, *Enterococcus* spp., coagulase-negative *Staphylococcus*, *Streptococcus uberis*). Acute mastitis is among the most infectious ailments in wide dairy cows, as ^[28]. Mastitis also can end up causing an inspirational dispute in a cow's behavior priority areas. To investigate this, we observed the behavior of six cows following acute mastitis induction. Cattle spent that time telling lies just on initiation day than previous day, and much less duration just on side of the acute inflammatory udder quarter. During a day, cows also spent more time overall eating silage. We propose that pain in the udder supersedes the motivational state of the cows' sickness behavior.

Mastitis is the most common and accepted disease of dairy cattle globally, causing huge losses to the dairy sector under unhygienic conditions. This becomes a serious quandary in dairy cattle, with substantial financial penalties, the risk of the spread of milk-borne diseases, and primarily a decline in milk yield and impaired milk quality ^[29]. Mastitis is generally classified into two types: Evert and subclinical. In clinical mastitis, the basic signs of inflammation (heat, pain, swelling, redness, and loss of function) are present, whereas in sub-clinical mastitis, there is no visible sign of inflammation. SCC in milk increased in subclinical mastitis by nearly 75-80 percent worldwide ^[30]. Milk quality is harmed, and production declines, reducing the income of poor farmers and causing farming yield loss points to a strong to mastitis, which directly threatens safety. Subclinical mastitis has a substantially greater prevalence than clinical mastitis. Gram-negative bacteria (25 to 30%), coagulase-negative *Staphylococcus* (20%), *Staphylococcus aureus* and *Escherichia coli* (5 to 10% each), *Streptococcus* and *Enterococcus* (2 to 5%), and other species (less than 2%) are the most common pathogens that cause mastitis ^[31]. Mastitis costs are determined by a variety of factors, much as other illnesses. Reduced milk production, veterinary services, diagnostics, medications, abandoned milk, and labor are the most typically addressed issues. Although factor costs vary by country and area, the economic concepts that underpin them remain the same ^[9,8].

Culling

The culling of animals is a tough issue to assess because it is caused by other factors (excluding in the circumstance of demise for reasons other than culling). The dairy farmer makes the decision to cull. When replacement is the best option, a cow is culled. Cows

with mastitis are more likely to be culled. Mastitis is perhaps the most common production illness in dairy herds worldwide ^[20]. Mastitis economies must be handled at the farm and are dependent on local and regional epidemiologic, managerial, and economic variables ^[18].

Why *S. aureus* is of major economic impact?

Dairy farmers suffer higher economic losses due to subclinical mastitis, which is a major issue among dairy cattle. This disease is one of the most common reasons of low milk production and poor milk quality, and it is also the major cause of considerable losses for dairy farmers ^[32]. Mastitis is one of the most expensive diseases in terms of production losses among animal diseases that affect the profitability of raising animals ^[33]. According to total milk production, Pakistan ranks 4 in the world, but its dairy industry isn't very well developed as animals are kept in small group ^[34]. Only a few species of bacteria cause mastitis among the many are predominant. A common pathogen is *Staphylococcus aureus*. Therefore, *S. aureus* mastitis in cows is hard to eliminate. Hence the need to enhance the existing technologies used to control *S. aureus* mastitis, given its economic impact, as well as food security and antibiotic consumption challenges ^[35]. Mastitis control is a concern all over the world, posing a serious threat to the dairy industry and complicating animal care maintenance ^[36]. As *S. aureus* mastitis is a transmissible illness that banquets from infected udders to healthy cows, sanitation is critical. Cleaning and drying udders prior milking, using properly designed milking machinery, dry cow treatment, culling chronically infected cows, milking sick cows in a distinct category, and developing an dynamic milk superiority programmed are all things that should be considered ^[34].

To avoid reintroducing bacteria in a *S. aureus*-free herd or implementing new pathogens to an infected herd, proper biosecurity measures are critical ^[35]. Presence of pathogens in a healthcare product does not necessarily indicate that this product was an external source of pathogens. In a cluster of *Serratia* outbreaks, farm-specific strains of the pathogen were identified, and the outbreaks were associated with unhygienic handling of teat-dip, resulting in contamination with *Serratia*, and subsequent growth ^[37]. By using diagnostic tests and keeping good records of cases and treatments, mastitis control can be targeted at specific pathogens to reduce the incidence of the disease. The health management program in each herd should include special consideration for the health of the udders ^[38].

Consequently, further refinement is necessary before it can directly identify *S aureus* in milk samples. Recently,

the LAMP assay was reported to be able to detect *S. aureus* in milk within two hours^[39]. The development of rapid and sensitive methods of determining contagiousness, pathogenicity, and antibiotic resistance, as well as cost-effective tools to test for antibiotic resistance, needs to be pursued to improve treatment and control measures. It will prevent the introduction of new, highly contagious strains and improve herd biosecurity when dry cows, non-lactating heifers, and latent carriers are tested prior to purchase^[35]. Mammary glands are equipped with antibacterial systems, but their effectiveness against mastitis is very limited. Vaccination against mastitis is the most common method of improving natural immunity in dairy cows. It has taken many years for vaccines against *S. aureus* and, more specifically, *S. aureus* mastitis to make it to market. In order to be effective, an ideal *S. aureus* mastitis vaccine would prevent infection, or facilitate its clearance from the mammary gland shortly after IMI, thereby preventing long-term intra mammary infections that serve as reservoirs for herd-mates' infections^[35]. The diet plays a crucial role in the resistance to disease, and some trace substances and vitamins are predisposing factors for mastitis, including selenium, copper, zinc and vitamin E. A decrease in vitamin A, E, and Zn concentrations at calving could negatively impact the immune system of the cow, following calving^[34]. For dairy cows with high yields, current dietary recommendations may not be sufficient to ensure optimal immune function and response around parturition^[40]. A diverse approach is required to effectively combat this condition. Many knowledge gaps, including vaccine development, are impeding progress in diagnostic, therapy, and prevention^[35,39].

4. Other than *S. aureus* Mastitis for Economic Impact

Mastitis causes significant economic losses to the dairy cattle industry. Mastitis usually caused by *Escherichia coli* (*E. coli*), *Streptococcus agalactiae*, *Staphylococcus aureus*, and *Klebsiella pneumonia*^[41,42].

Escherichia coli (*E. coli*)

E. coli are among the most common pathogens causing ecologic mastitis. It generally targets the mammary gland all through milk yield, and if remain unattended, it can be potentially lethal. The most major reason of mortalities is acute clinical *E. coli* mastitis. This same intensity of the infectious disease, stage of milk production, energy balance, vitamin deficiency, and vaccination status all influence the treatment outcomes of *E. coli* mastitis^[43].

Mastitis induced by *Escherichia coli* (*E. coli*) continues to be a potential danger to dairy cattle, affecting animal rights and causing significant economic deficit. It is still a fatal condition in dairy cattle all over the globe. It endangers mammary gland health, reduces dairy productiveness, stifles bovine expansion, raises rearing and preventative measures costs, and has a deleterious impact on animal wellbeing^[44].

Klebsiella pneumonia

Although *K. pneumoniae* is typically assumed to be an ecologic representative which is mostly prevalent in and transferred through the atmosphere, it can every once in a while spread the infection cow to a better and healthier cow^[45]. This is most prevalent in bedsheets, especially shavings and perlite, which serve as main water sources for this pathogen. Water and soil seem to be two other potential environments for this microbe to survive and prosper^[46].

K. pneumoniae is among the known causes of mainly environmental *Klebsiella pneumoniae* mast it is in the dairy sector and it has been the subject of many studies^[47]. Clinical mastitis (CM) is a situation whereby an animal exhibits physical effects of mastitis and dairy productivity and processing are also impacted^[48]. While most research shows that treatment has a minimal effect. After using antibiotic to treat non-severe instances of *Klebsiellapneumoniae* associated CM, there was a substantial increase in microbiological cure. Mastitis reduces milk yield, and most cows do not restore to normal production levels after recovery^[49] resulting in significant economic losses. It's also been noted that the degree of milk supply reduction varies according to the pathogen that causes the infection, with Gram negative bacteria producing a bigger decrease than Gram positive bacteria and other non-bacterial species^[49].

Streptococcus agalactiae

Numerous types of observational evidence suggest that milking employees may transfer *Str. agalactiae* into bovine herds, according to^[50]. *Str. agalactiae* strains isolated from udder mastitis and human infections were found to share 58 percent genetic similarity in a research, while clustering revealed that they shared 70 percent genetic similarity^[47]. In animal-to-animal transferred genotypes, the aspect of self is extremely low. Young cattle during their first feeding period are much more immune to infectious causal factors, according to circumstantial data. The disease can persist inside the udder for a long period of time and be undiagnosed. These

animals serve as reservoirs for infections and spreaders of the disease ^[19]. Cow mastitis is by far the most common illness in dairy cattle around the world. Bacteria, such as *Streptococcus agalactiae*, are the principal etiologic agents ^[18]. This agent is crucial in bovine mastitis since it is highly contagious and also has a significant impact on the development of diagnostic mastitis as well as the rise in bulk milk somatic cell counts ^[49].

Minor mastitis pathogens

Microbes that possibly cause mastitis Secondary mastitis infections include non-haemolytic coagulase-negative staphylococci (CNS) and *Micrococcus* spp. It can considerably raise the leukocyte counts in milk in rare situations. They now are one of the most frequent bacteria discovered in milk cultures, particularly in herds with sufficient control of major diseases. They are part of the natural teat flora and function as opportunist pathogens, causing disease when the conditions are right ^[35,49]. *S. epidermidis*, *S. hyicus*, *S. intermedius*, *S. chromogenes*, *S. hominis*, *S. warneri*, and *S. xyloso* are among the coagulase-negative staphylococci. *S. epidermidis* and *S. hyicus* are the most usually isolated bacteria from cow mastitis. *Bacillus* spp., *Pseudomonas* spp., and *Corynebacterium* spp. are among the infections that cause mastitis less frequently. *Bacillus cereus* and *Bacillus subtilis* are saprophytic bacteria detected in mix infections and mastitis induced by teat injury among *Bacillus* organisms ^[35].

Environmental pathogens

These are pathogens common in the cow's surroundings, and intra-mammary infections result from teat end exposure to these pathogens between milking. Environmental infections are responsible for 40% of cases each year ^[51]. On the well farms, environmental pathogens are responsible for the majority of mastitis episodes, and the majority of IMI cases caused by environmental pathogens are attributed to coliforms and environmental streptococci ^[51,35].

5. Mastitis Recommendation and Prevention

The majority of recommended mastitis control techniques were considered to be economically advantageous, according to ^[52]. It was not cost effective to use a sanitizer in the cleaning solution and have a business adjust the milking machine inflations. The SCC of a single cow was a better predictor of milk loss than the SCC of a bulk tank. Questions have been raised about cost-effectiveness and effectiveness of treatment every cattle at dry off rather than just a few. Under field conditions,

a DHI survey was paired with DHI production data to determine the association among milk production, SCC, management practices, and production parameters ^[51,32].

Mastitis preventive and control measures include: a) public trough disinfection, b) milking operations that comply to hygienic principles, c) removal of cows with chronic mastitis, d) dry cow treatment with antibiotics, and e) treatment of mastitis ^[52]. The plan also includes keeping a clean and comfortable environment by managing bedding, keeping places clean and dry, ensuring sufficient ventilation, and providing feed shortly after milking ^[51]. Establishing udder health goals and reviewing them to priorities changes in management to meet those goals, maintaining a clean and comfortable environment through bedding management, keeping areas clean and dry, ensuring proper ventilation, and providing feed soon after milking to keep animals in standing position ^[53].

6. Conclusions

The economic repercussions of mastitis (clinical or subclinical) appear to be attributable to treatment, production losses, culling, changes in product quality, and the risk of additional illnesses, according to this research. Mastitis is one of the most expensive diseases in terms of production losses among animal diseases that affect the profitability of raising animals. *S. aureus* mastitis is a contagious illness that spreads from infected udders to healthy cows. Mastitis control is a concern all over the world, posing a serious threat to the dairy industry and complicating animal care maintenance. Mastitis reduces milk production, changes milk composition, shortens the productive life of infected cows, and is very costly to the dairy farmer. The associated costs can be divided among the following factors: milk production losses. Mastitis represents a most costly health and economic issue inside the dairy industry. Mastitis is by far the most expensive significant social and economic issue in the dairy sector. Farmer must concentrate on avoiding mastitis infection whilst putting in place and following a mastitis control program. Aimed at limiting antimicrobial use and implement novel ways in dairy cattle also may aid in the prevention and treatment of this disease.

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